

MSU Technologies Multi-Material 3D Printer

Quick User Manual and Standard Operation Procedure

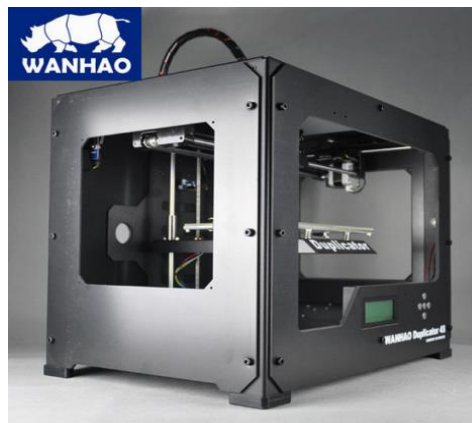
Design Team #11

Sponsor: MSU Technologies

Facilitator: Chuan Wang

Matthew Luzenski

April 3, 2015



Summary

This application note is a basic guide to the Multiple Material 3D project and operating the Wanhao Duplicator 4S printer and Replicator G. Printer specifications are given and a standard operation procedure is described that will allow new users to operate the printer effectively.

Contents

Introduction	2
Specifications	2
Standard Operating Procedure	3
A. Build a 3D model	3
B. Generate Gcode for printing	3
C. Printer Operations	5
References	8

Introduction

The MSU Technologies multi-material 3D printer is an active project that has the capability of building plastic 3D models using a Wanhao Duplicator 4S dual-extrusion 3D printer. In the future the printer will be modified to create embedded metal wiring using a metallic plasma deposition head. The goal of this application note is to give a brief overview of how the printer should be operated. A standard procedure should be followed in order to decrease the difficulty of use and limit the time lost to erroneous operation and unfamiliarity. This document will allow the user to quickly be oriented with the project and conduct prints within specifications.

Printer Specifications

The Wanhao Duplicator 4S used for this project is a stainless steel printer chassis with 3-axis control for fused deposition modeling (FDM). The printer takes input from a wall socket and uses 24V DC @ 6.5A. Operation requires .Gcode files created by Replicator G that are read from USB or SD card. The Wanhao Duplicator 4S has plastic print specifications as follows.

- 100µm-340µm plastic layer resolution
- 11µm positioning precision in x and y axis
- 2.5µm positioning precision in z axis
- 22.5×14.5×15 cm maximum print dimensions
- Plastic Extruder Nozzle Diameter .4mm
- Compatible with 1.75mm diameter PLA/ABS filament

The Metal Deposition head will attach on the extruder carriage in the place of one of the plastic heads. The metal print is expected to have a much smaller resolution than the plastic extruder and the printer has been modified so that multiple passes will be written into the Gcode that controls the print instructions and the layer resolutions will be equalized.

Replicator G is the software interface that provides the slicing and code generations that are necessary for the operation of the 3D printer. Replicator G takes .stl files and allows manipulation on a virtual build plate. Several options can be selected so that prints are made to the user's requirements and the code output to the 3D printer creates a part properly.

Standard Operation Procedure

The standard operation procedure for the MSU Tech printer can be broken down into three steps. The first step is building a 3D model in a software of choice and producing a file that can be used by Replicator G and passed on to the printer. The second step is creating Gcode controls that will be used by the printer. Finally the part can be fabricated by operating the 3D printer.

A. Building a 3D model

3D models for printing must be created in software that produces a .stl output file that can be read by the slicing software in Replicator G. For this project we use Siemens PLM NX 9.0 for modeling. 3D models must be made so that they will balance on the build plate or have supports that will keep the part still while printing. For multiple material prints two 3D models must be made and will later be used together in Replicator G. Make a model for each material and save both as an independent .stl file

B. Creating Gcode for printer control

Open Replicator G and click the file menu and open the .stl in the extruder for the material you want to build in. For extruding in two materials go to the Gcode menu and select Merge .stl for DualExtrusion, open the .stl files in their appropriate extruder location. Move the object(s) to the desired orientation (For multiple materials align the files so that they appear as you want them to be printed). Select Generate from the Gcode menu. In the Gcode dialogue box select the desired settings:

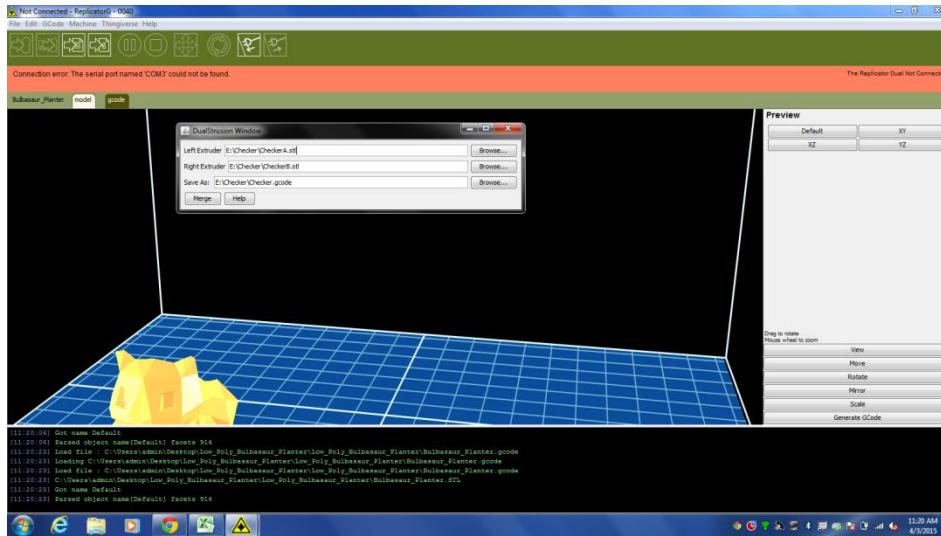


Figure 1 Opening multiple .stl

- Object Infill (%): this option determines how much plastic will fill the volume of your build.
- Layer Height: This is the plastic layer resolution.
- Number of shells: This is the number of passes that create the outer part of your build.
- Feedrate: Speed of Extrusion.
- Travel Feedrate: Speed of carriage while not extruding.

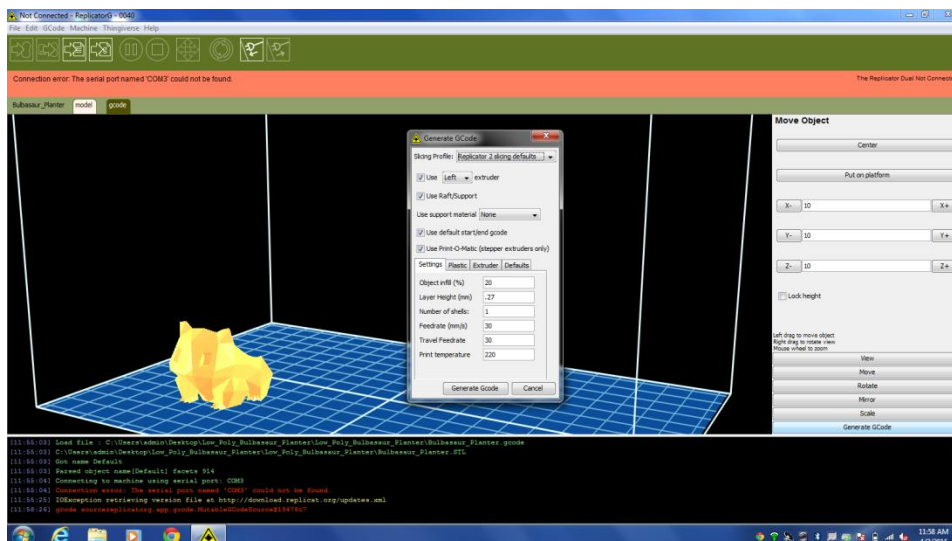


Figure 2 Generate Gcode dialogue box

Now select the updated settings from the Gcode post processing menu

- Temperature Control: Extruder and bed temperatures can be disabled or determined here.
- Multipass: This will allow you to repeat tool paths to create duplicate layers.

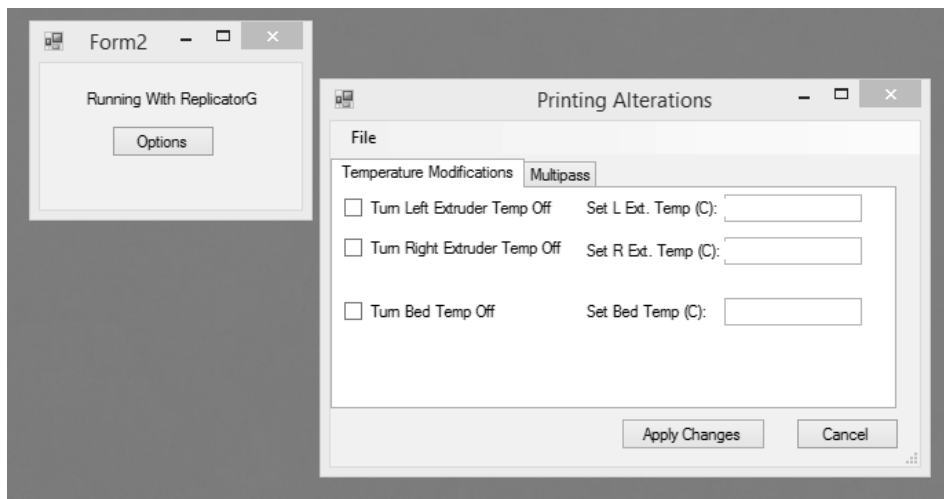


Figure 3 Gcode Post-processor window

When settings have been verified, ensure you have the printer SD card inserted in your computer and click the Build File for use with SD card. Save the file in the root folder and remove the SD card and begin printer operation

C. Printer Operation

Gently insert the SD card into the receiver slot located on the inside on the printer behind the LCD screen on the right side. Once inserted select Build from SD in the main menu and begin the print. At this point the printer will begin the build or preheat to your selected bed temperature. Wait for the build to finish and plastic to cool before removing the finished part from the build plate. Build completion and approximate time remaining can be accessed from the >Bot Statistics feature in the >Info and Settings menu. The print can also be canceled early at any point during the build.

Build Plate Basics

The build plate is the metal sheet that a part is printed on. It should always be covered by a yellow kapton sheet the helps plastic adhere to the build plate. If the kapton sheet is sufficiently

dirty or torn carefully remove and replace the sheet with a new one. A glass plate can be placed on top of the build plate if desired. The build plate can be preheated before prints. Typical operation requires a temperature of 110C for ABS plastic and 50C for PLA. Typical extrusion temperatures are around 220C.

Build Plate Leveling

In order to ensure proper adhesion to the build plate and a good print, the build plate should be occasionally checked for leveling. The build plate has four knobs with springs that move the plate up and down on the mount. The build plate can be leveled by selecting >Level Build Plate in the >Utilities menu on the LCD screen of the Duplicator 4S.

1. To begin, tighten or loosen the knobs to get the plate in a position that it appears level.
2. Then bring the build plate up to the extruder nozzles to a point where a piece of paper can slide between with some friction.
3. Move the extruder around to check that the paper slides with some friction across the entire build.
4. The build plate will be level and you can end the leveling program.

Loading Plastic Filament

The Duplicator 4S is compatible with both PLA and ABS plastic filaments. Following are the procedures for loading and removing filament from the plastic extruder.

Loading filament

1. For loading, begin by detach the filament sleeve from the top of the extruder.
2. Guide the filament through the protective sleeve and above the extruder.
3. Start heating the extruder using >Change Filament in the >Utilities LCD menu.
4. When the extrusion head reaches 220 C hit okay and push the filament into the extruder.
5. Wait until plastic begins extruding from the nozzle.
6. End the extrusion and remove the excess extruded plastic.
7. Put the sleeve back in the opening on top of the extruder to finish loading filament.

Removing filament

1. To remove filament from the extruder, begin by detaching the protective sleeve.
2. Start heating the extruder using >Change Filament in the >Utilities LCD menu.
3. When the extrusion head reaches 220 C remove the filament and any excess plastic that was extruded from the nozzle.

References

More in depth printer instructions and illustrations can be found in the Duplicator 4/4X/4s Desktop 3D Printer User Manual. <http://wanhao3dprinter.com/main.aspx?id=2013020021>

<http://replicat.org/usage>